MIDDLE MIOCENE MARINE BIRDS FROM THE FOOTHILLS OF THE SANTA ANA MOUNTAINS, ORANGE COUNTY, CALIFORNIA

Hildegarde Howard[1] and Lawrence G. Barnes[2]

ABSTRACT. A mixed marine and non-marine fossil vertebrate assemblage of Middle Miocene age has been recovered from several localities on both sides of Oso Creek in the foothills of the Santa Ana Mountains in Orange County, California, U.S.A. The fossils were found during grading operations for construction of Upper Oso Dam, and were derived from a coarse clastic marine rock unit. This rock unit, which crops out near the southeast margin of the Los Angeles Basin (both a topographic and depositional feature), has been mapped as the Topanga Formation. It overlies rocks assigned to the Early Miocene Vaqueros Formation and is in turn overlain by rocks mapped as the Late Miocene Monterey Formation.

Among the available sample of 54 avian bones in the assemblage from Upper Oso Dam are fossils representing *Diomedea ?milleri* Howard (albatross), *Puffinus priscus* Miller, *Puffinus* ?new species, *Puffinus* spp. (shearwaters), Sulidae (boobies and gannets, two species), Anatidae (undescribed large diving duck), and *Alcodes,* aff. *A. ulnulus* Howard (flightless auk). This is the oldest fossil avifauna yet described from Cenozoic marine strata in the Orange County area, and the only marine avifauna in California of Middle Miocene age that has yet been reported from south of the outcrops of the Sharktooth Hill Bonebed in Kern County. The birds in the assemblage from Upper Oso Dam have their closest affinities with the species from the Sharktooth Hill Bonebed. No species of alcids are known from that bonebed, however, and the primitive flightless auk genus, *Alcodes,* had been previously recorded only in slightly younger, Late Miocene fossil assemblages from the Monterey Formation in Orange County.

INTRODUCTION

From 1978 to 1983, field parties organized by the Natural History Museum of Los Angeles County (LACM) collected fossils from Middle Miocene marine sediments in the Oso Creek area (Fig. 1) in the foothills of the Santa Ana Mountains near Mission Viejo, Orange County, California (Raschke, 1984). The fossil-bearing sediments were exposed during the mechanized grading of hills on both sides of Oso Creek during construction of an earth-fill dam, named Upper Oso Dam (33°39′30″ north latitude, 117°37′35″ west longitude). The subjects of the present study are the 54 bird bones thus obtained which represent probably 34 individuals.

The bones were found in a gray and yellowish-red colored, pebble-bearing, coarse sand deposit that is several meters thick and has been identified on geologic maps (e.g., Morton et al., 1973:pl. 1) as belonging to the Topanga Formation. These sediments at Upper Oso Dam directly underlie shales and siltstones that have been mapped as the Monterey Formation, which is Late Miocene in age. The Monterey Formation has elsewhere yielded the birds that were previously reported by Howard (1966, 1968, 1976, 1978) from localities in Laguna Hills (Leisure World) and Laguna Niguel, approximately 10 km to the southwest in Orange County (Fig. 1).

It may no longer be correct to refer to the coarse sands at Upper Oso Dam as the Topanga Formation because the type section of that formation is in the Santa Monica Mountains, approximately 100 km to the north within the Los Angeles Basin, where the name has been elevated to the status of a group (Yerkes and Campbell, 1979). Because the Topanga Formation is no longer used in the Santa Monica Mountains, and because of lithologic differences and the lack of lateral continuity between the two areas, the formation name is probably no longer applicable to rocks anywhere in Orange County.

Raschke (1984) provided a preliminary notice of the occurrence of vertebrate fossils at Upper Oso Dam, and future reports will be published on the geology in the vicinity and on the other fossils. The fossil assemblage from the Middle Miocene sediments at Upper Oso Dam is correlated with the Barstovian North American Land Mammal Age and the Sharktooth Hill Local Fauna from the Round Mountain Silt in Kern County, farther north in California (Raschke, 1984: 64). Some evidence for these age determinations derives from

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[1] Chief Curator Emeritus, Earth Science Division, Natural History Museum of Los Angeles County, Los Angeles, California 90007.

[2] Curator and Section Head, Vertebrate Paleontology, Natural History Museum of Los Angeles County, Los Angeles, California 90007.

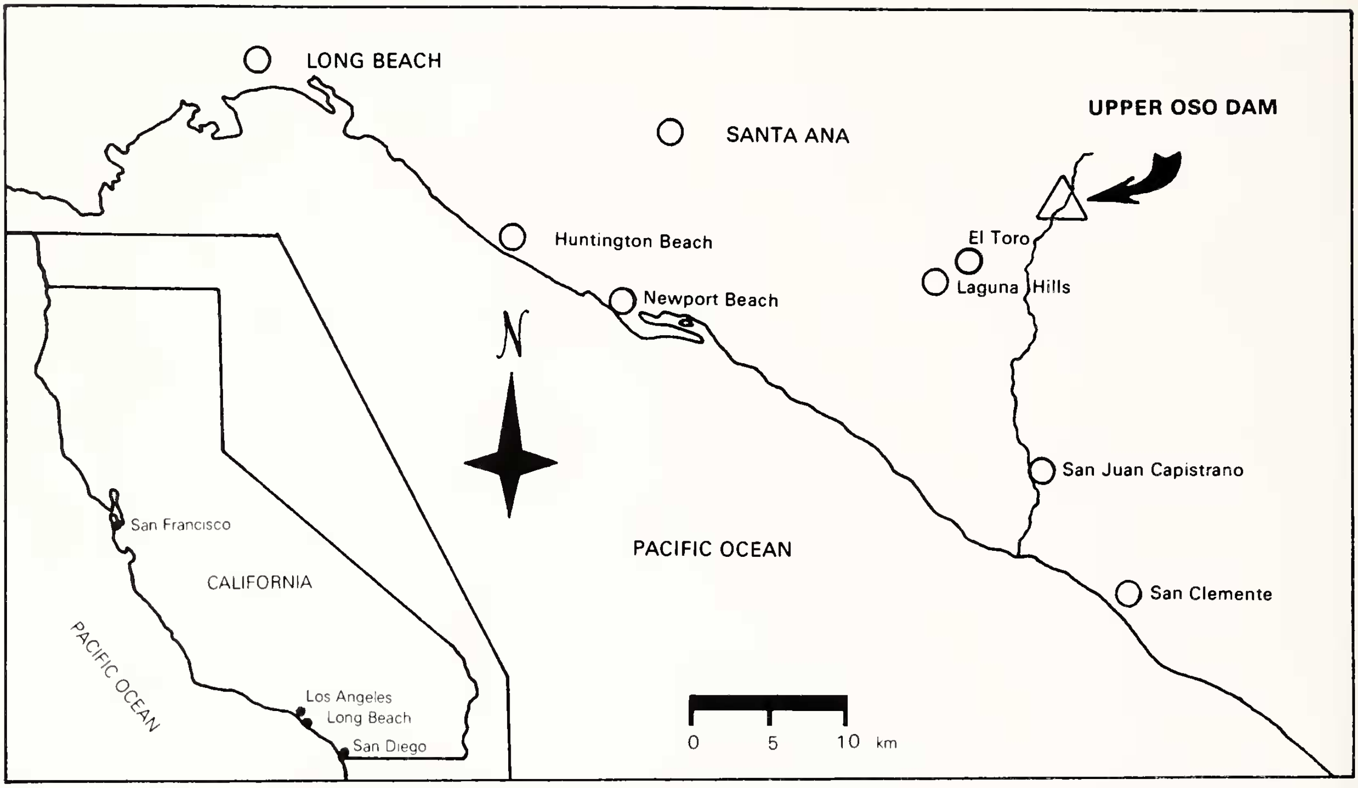

Figure 1. Location of the sites that produced the fossil birds described in this study, at Upper Oso Dam, Oso Creek, Orange County, California.

unpublished data from other fossil specimens in the LACM from Upper Oso Dam, including those of sharks, bony fishes, turtles, and mammals. Among these other taxa, the sharks and mammals are probably the most useful age indicators, considering the state of our knowledge of Pacific coast marine and terrestrial vertebrates. The shark assemblage is typically Middle Miocene in aspect and includes *Isurus hastalis* (Agassiz, 1843); *I. planus* (Agassiz, 1856); *Isurus* spp.; *Procarcharodon megalodon* (Agassiz, *in* Charlesworth, 1837); *Carcharinus* sp. and/or *Negaprion* sp.; *Galeocerdo aduncus* Agassiz, 1843; *Hemipristis serra* Agassiz, 1843; *Squalus serriculus* Jordan and Hannibal, 1923; *Squatina lerichei* Jordan and Beal, 1913; and *Myliobatis* sp. These have similar morphologies and occur in approximately similar relative abundances as do the same taxa from the Sharktooth Hill Bonebed. Terrestrial mammalian taxa from Upper Oso Dam, not strictly limited to, but characteristic of the Barstovian Land Mammal Age, include a horse, *Merychippus* sp.; a stilt-legged camel, *Aepycamelus* sp.; and a large paleomerycid (Raschke, 1984:64). The mammals also include at least three species of otariid pinnipeds: *Allodesmus* sp., *Neotherium* sp., and an undescribed genus and species. The same or similar species of all three of these pinniped genera occur in the Sharktooth Hill Bonebed. Among the odontocete cetaceans from Upper Oso Dam are *Kentriodon* sp., cf. "*Squalodon*" *errabundus* Kellogg, 1931, and a large, unnamed species; again, all similar to, or the same as, taxa from the Sharktooth Hill Bonebed. The age of that bonebed, as determined on the basis of several lines of evidence (see Barnes, 1976; Barnes and Mitchell, 1984), is late Middle Miocene, correlated with the Barstovian North American Land Mammal Age (Wood et al., 1941, the "Temblor" provisional provincial mega-invertebrate stage of Addicott (1972), and the Relizian or Luisian foraminiferal stage, and is between approximately 13 and 15 million years old. Additional, indirect evidence for the Barstovian age of the vertebrate-bearing sands at Upper Oso Dam is the fact that they overlie strata referred to the Vaqueros Formation (Morton et al., 1973:pl. 1), which have produced land mammals that are characteristic of the Hemingfordian North American Land Mammal Age (Raschke, 1984:62, fig. 1; D.P. Whistler, personal communication).

Unfortunately, many of the bird bones from Upper Oso Dam that we describe here are fragmented, crushed, and distorted. Some of this is the result of geologic phenomena, but some resulted from the fossils' being scraped and run over by machinery. Specific identifications have, therefore, been difficult. Five families are represented, the most abundant of these being the shearwaters (family Procellariidae, 26 bones, 16 individuals), and the booby-gannet family (Sulidae, 22 bones, 10 individuals). Other fossils belong to members of the albatross family (Diomedeidae, two bones of one individual), waterfowl family (Anatidae, one bone), and auk family (Alcidae, three bones of three individuals). At least eight species are represented. (We did not calculate minimum numbers of individuals, but made our determinations on the basis of the stratigraphic and geographic separation of the specimens.)

The families Procellariidae and Sulidae are well represented in the fossil record, with seven species of the Sulidae and eight species of the Procellariidae (including two fulmars) having been previously described from California Miocene deposits (Howard, 1983). A thorough study of each of these families is needed and, therefore, identifications herein of the shearwater and sulid specimens should be considered tentative. The Sulidae are now in the process of being reviewed by K.I. Warheit of the Department of Paleontology at the University of California, Berkeley. Fossil avian species have been described from the Sharktooth Hill Bonebed by Wetmore (1930), Miller (1961, 1962), Howard (1966, 1984), and Warter (1976). Howard (1983) summarized these and other published records of fossil birds from California.

MATERIALS AND METHODS

Acronyms used for institutions are:

CAS: California Academy of Sciences, San Francisco, California.
LACM: Natural History Museum of Los Angeles County, Los Angeles, California.
UCLA: University of California at Los Angeles, California.
UCMP: University of California Museum of Paleontology, Berkeley, California.
UCMVZ: University of California Museum of Vertebrate Zoology, Berkeley, California.
USNM: National Museum of Natural History, Smithsonian Institution, Washington, D.C.

In addition to the fossil material in the LACM collections, referred specimens and casts of holotypes from CAS, UCMP, UCLA, and USNM have been available for this study. An accurate cast of the holotype of *Puffinus inceptor* Wetmore, 1930, was used for comparisons instead of the original specimen (CAS 5223). Modern skeletal material is from the LACM collections, with the exception of specimens of *Aethia pusilla* (Pallas, 1811), which are from UCMVZ. The fossils described from Upper Oso Dam are from LACM localities 4545, 4546, and 4547 which, in that order, are progressively older and stratigraphically lower within the deposit. The locality number LACM 4464 is assigned to fossils that were found weathered out and loose at LACM localities 4545, 4546, or 4547, and therefore lacking more precise stratigraphic data. The classification herein follows that of the Sixth Edition of the American Ornithologists' Union Checklist of North American Birds (1983).

SYSTEMATICS

Order Procellariiformes

Family Diomedeidae (albatrosses)

Diomedea Linnaeus, 1758

Diomedea ?milleri Howard, 1966

Figure 2C

REFERRED SPECIMENS. Associated proximal half of right ulna and distal end and shaft fragments of right radius from one individual, LACM 120439, from LACM locality 4547.

DISCUSSION. Albatross bones have been previously reported from several Miocene age sites in California, but only two species, both first recognized on the basis of fossils from the Sharktooth Hill Bonebed, have been named: *Diomedea californica* Miller, 1962, and *D. milleri* Howard, 1966. *Diomedea californica* has also been found in the Late Miocene Monterey Formation in the Laguna Hills in Orange County (see Howard, 1978). The holotype of the species is a tarsometatarsus, slightly larger than that of the living Short-tailed Albatross, *D. albatrus* Pallas, 1769, but not as large as that of the extant Wandering Albatross, *D. exulans* Linnaeus, 1758. *Diomedea milleri* is a considerably smaller species, and is still known only from the Sharktooth Hill Bonebed. Its holotype is the proximal end of an ulna having a proximal breadth of 14.4 mm, as compared to 17.6 mm for the same bone of the living Black-footed Albatross, *D. nigripes* Audubon, 1839 (see Howard, 1966:4).

The albatross ulna, LACM 120439, from Upper Oso Dam (Fig. 2C), is 15.8 mm for the same measurement. The radius associated with this ulna is also narrower of shaft than is the same bone of a Recent *D. nigripes*. The area immediately distal to the ulnar cotylae, which contains the diagnostic characters of the species *D. milleri*, is crushed on LACM 120439. However, a clearly defined ridge on the palmar side of the shaft below this area suggests that there was a distinct angle between the palmar and internal surfaces of the shaft immediately below the internal cotyla, as was described for *D. milleri*. Although the present specimen, LACM 120439, appears to have a more prominent acromion and external cotyla than does the holotype of *D. milleri*, these areas are slightly eroded in the latter, possibly altering its morphology.

Family Procellariidae (shearwaters)

Puffinus Brisson, 1760

Puffinus priscus Miller, 1961

Figures 2A, B, F, G

REFERRED SPECIMENS. Left humerus, LACM 120415; associated right and left humeri and incomplete right

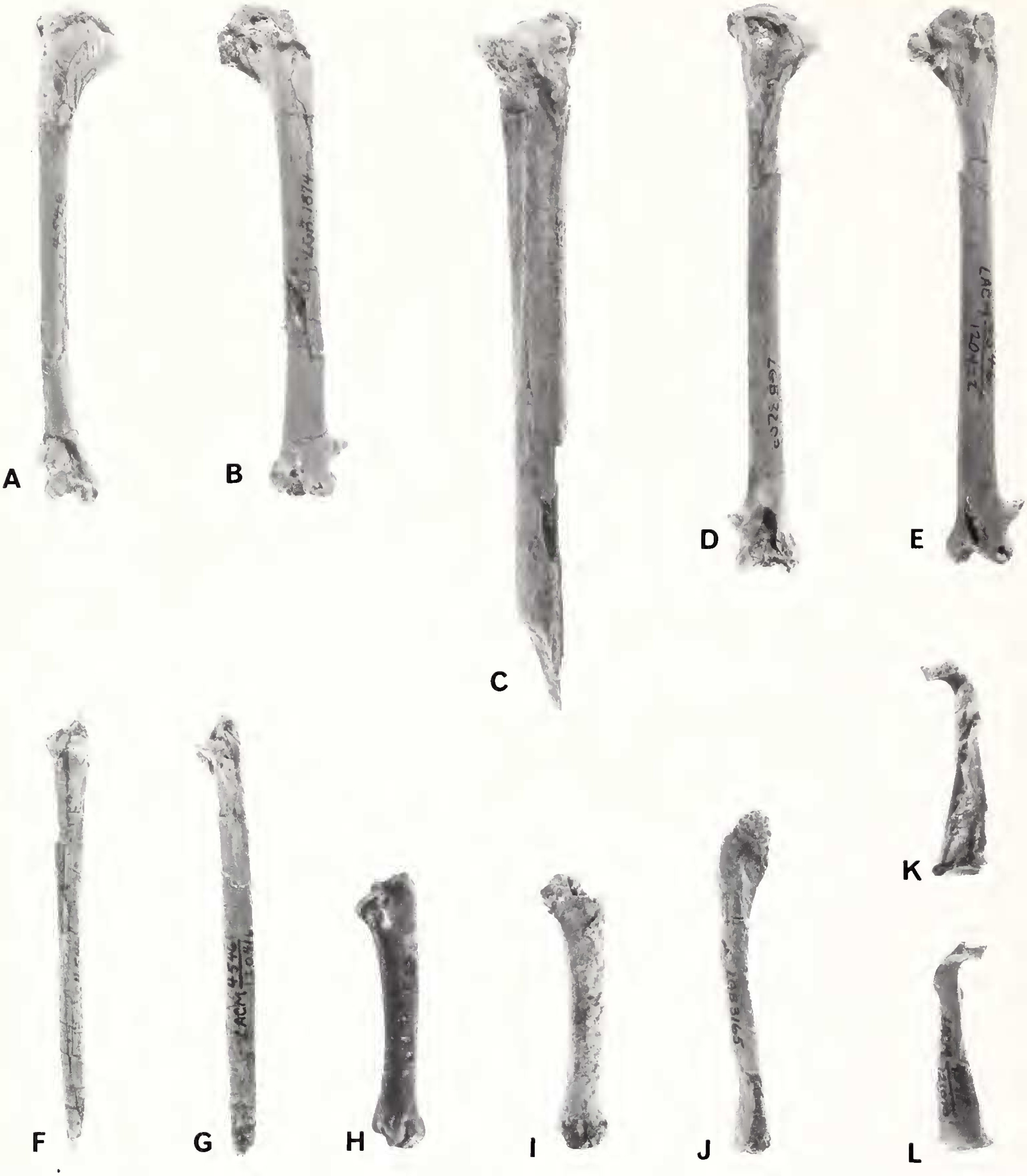

Figure 2. **A, B,** *Puffinus priscus* Miller, 1961, right humerus, LACM 120416, palmar and anconal views; **C,** *Diomedea ?milleri* Howard, 1966, right ulna, LACM 120439, internal view; **D, E,** *Puffinus* ?new species, right humerus, LACM 120422, palmar and anconal views; **F, G,** *Puffinus priscus* Miller, 1961, right ulna, LACM 120416, palmar and internal views; **H, I,** external views of left ulnae of *Alcodes* Howard, 1968; **H,** *A. ulnulus* Howard, 1968, holotype, LACM 18277, from Monterey Formation in Laguna Hills, LACM locality 1945; **I,** *Alcodes,* aff. *A. ulnulus* Howard, 1968, LACM 120434, from Upper Oso Dam, LACM locality 4546; **J–L,** *Alcodes,* aff. *A. ulnulus* Howard, 1968; **J,** left humerus, LACM 120414, anconal view; **K, L,** right coracoid, LACM 121010, posterior and anterior views. All views natural size, except **H** and **I,** which are ×1.5.

ulna from one individual, LACM 120416; distal end of right humerus, LACM 120417; proximal fragment of left ulna, LACM 120424; all from locality LACM 4546. Proximal three-fourths of right humerus, LACM 126159, from locality 4464.

TENTATIVELY REFERRED SPECIMENS. Right and left distal ends of tibiotarsi, LACM 120425 (right) and 120426 (left); right tarsometatarsus lacking proximal end, LACM 120419; all from locality 4546.

DISCUSSION. The referred humeri from Upper Oso Dam agree in their general conformation, in their size, and in the flatness of their shafts (Figs. 2A, B) with the holotypic distal end of this element (UCMP 58185) from the Sharktooth Hill Bonebed and/or with additional unpublished specimens (three of which—LACM 18140, LACM 44556, and LACM 126219—are complete) from the same stratum, that are now referable to *Puffinus priscus* Miller, 1961. Howard (1968:7–8) questionably referred a partial humerus from the Late Miocene age Monterey Formation in Orange County to the same species. The ranges of measurements of the humeri from Upper Oso Dam are: length—79.3 to 81.2 mm, breadth of distal condyles—7.4 to 7.8 mm, distance from distal surface of condyles to proximal surface of ectepicondylar prominence—9.5 to 9.9 mm. The same measurements of humeri from the Sharktooth Hill Bonebed which are assigned to *P. priscus* are: length—80.3 to 82.5 mm (n = 3), breadth of distal condyles—7.1 to 7.7 mm (n = 6, holotype—7.5 mm), and distance from distal condyles to proximal surface of ectepicondylar prominence—8.9 to 10.0 mm (n = 5, holotype—9.5 mm).

Each of the two ulnae, one of which (Figs. 2F, G) is associated with humeri (LACM 120416), has a high, pointed olecranon (possibly exaggerated by crushing) and a long, pointed, and upturned external cotyla. These characters are suggestive of those of the extant Black-vented Shearwater, *P. opisthomelas* Coues, 1864, although to an exaggerated degree.

The tarsometatarsus, which measures 6.1 mm in distal breadth, is tentatively assigned to *P. priscus* on the basis of favorable comparisons between it and tarsometatarsi of the species from the Sharktooth Hill Bonebed. Of the three tarsometatarsi of *Puffinus* now available from the latter locality, one specimen (LACM 104058) is incomplete, comprising only the distal half. It agrees in size with LACM 120419 from Orange County, is slightly smaller than the other two, and, we believe, is assignable to *P. priscus*.

The tibiotarsi resemble the only distal end of this element assignable to *Puffinus* that has been found in the Sharktooth Hill Bonebed, LACM 122994. That specimen is tentatively referred to *P. priscus* on the basis of its size relative to the tarsometartarsi noted above.

Puffinus ?new species

Figures 2D, E

REFERRED SPECIMENS. Associated, complete, but poorly preserved right humerus, crushed proximal end of ulna, and proximal and distal fragments of radius from one individual, LACM 120422, from locality LACM 4546; collected 23 April 1980 by L.G. Barnes.

DESCRIPTION. Although in general characters the humerus (Figs. 2D, E) resembles those of species in the subgenus *Puffinus*, the shaft is more rounded and less flattened throughout. It is, therefore, clearly distinguishable from the holotype of *P. priscus* Miller, 1961 (UCMP 58185), but slightly less so from the holotype of *P. mitchelli* Miller, 1961 (UCMP 58184) (casts of both holotypes are at hand). In length (90.4 mm), LACM 120422 is intermediate between three Sharktooth Hill specimens of *P. priscus* (80.2 to 82.5 mm) and the one measurable specimen (LACM 17500) of *P. mitchelli* (98.1 mm). Although the ulna from Upper Oso Dam is severely crushed, the breadth across the cotylae could not have exceeded 7.5 mm.

Poor preservation of this humerus from Upper Oso Dam makes difficult any detailed comparison with the holotype (CAS 5223) of *P. inceptor* Wetmore, 1930, which is the distal end of a humerus. The specimen from Orange County (LACM 120422) is broken through the internal condyle, but appears to lack the notable internal thrust of the distal end that is characteristic of *P. inceptor*, and is reflected in the measurements given by Wetmore (1930:87): breadth of shaft—5.9 mm, greatest distal breadth—12.2 mm. In the humerus from Upper Oso Dam, the shaft breadth is 6.3 mm, the greatest distal breadth 11.2 mm.

DISCUSSION. Many other Miocene species of the genus *Puffinus* have been previously recorded from California (see Howard, 1983). Among these, *P. diatomicus* Miller, 1925, from the Late Miocene age Sisquoc Formation in Santa Barbara County has the humerus represented in both the holotype and referred skeletal impressions. Miller (1925) measured the lengths of these humeri as 80 to 84 mm (considerably less than for LACM 120422). The humerus is also the holotype for each of the two previously named Late Miocene species from Orange County; *P. calhouni* Howard, 1968, and *P. barnesi* Howard, 1978. Each of these is smaller and has a more compressed shaft than does LACM 120422 from Upper Oso Dam. Compared with the holotypic distal end of a humerus of the Early Miocene species, *P. micraulax* Brodkorb, 1963, from Florida, LACM 120422 is broader. The holotypic distal end of the humerus of *P. conradi* Marsh, 1970, from the Middle Miocene Calvert Formation of Maryland, is broader and has a thicker shaft.

Although the humerus of LACM 120422 appears to be distinct from all of the above, the poor condition of the available material precludes naming a new species. Should more specimens assignable to this shearwater be discovered, comparisons should also be made with the French Middle Miocene species, *P. aquitanicus* (Milne-Edwards, 1874) and *P. antiquus* (Milne-Edwards, 1874). In fact, Olson (1985:211) has noted the need for a worldwide revision of fossils assigned to the genus *Puffinus*.

Puffinus, spp. undetermined

REFERRED SPECIMENS. Complete right ulna, LACM 120420; distal three-fourths of left ulna, LACM 124360;

proximal and distal ends of right ulna, LACM 120421; fragment of proximal end of left ulna, LACM 126155; associated fragments of distal end of ulna and proximal end of radius and carpometacarpus of one individual, LACM 126156; complete radius, LACM 120423; right carpometacarpus, LACM 120419; associated fragments of distal end of left ulna and tarsometatarsal shaft of one individual, LACM 126157; all from locality LACM 4546. Distal fragment of radius, LACM 120412; incomplete right humerus, LACM 126160; both from locality LACM 4464.

DISCUSSION. The size range alone among these specimens suggests that at least two species are represented. Most are of small size and in this respect are suggestive of *P. priscus.* One poorly preserved humerus (LACM 126160) and one ulna (LACM 120420) are, however, notably larger. This humerus has been partly restored, but appears to have a more flattened shaft toward the distal half of the bone than do humeri of *P. mitchelli* from the Sharktooth Hill Bonebed. The length of this poorly preserved humerus, from the proximal edge of the brachial impression to the head is 83.2 mm. The same measurement of a Sharktooth Hill humerus, LACM 17500, referred to *P. mitchelli,* is 86.6 mm. The ulna from Upper Oso Dam, LACM 120420, has a length of 95.7 mm. In contrast, the largest ulna known from the Sharktooth Hill Bonebed (LACM 124359) measures only 88.2 mm long. Both are markedly larger than the incomplete ulna (LACM 120416) from Upper Oso Dam that is associated with the humerus that we assigned above to *P. priscus.*

Order Pelecaniformes

Family Sulidae (boobies and gannets)

Sulidae, spp. undetermined

REFERRED SPECIMENS. Associated right and left humeri, right and left ulnae, and a badly crushed radius of one individual, LACM 120433; associated left coracoid and proximal fragment of shaft of left humerus of one individual, LACM 120428; right tarsometatarsus lacking part of proximal end, LACM 120432; proximal end of radius, LACM 120429; proximal end of humerus, LACM 120430; distal end of humerus, LACM 120431; skull fragment, LACM 120427; all from locality 4546. Associated incomplete radius and ulna of one individual, LACM 120438; humerus, LACM 123910; seven associated incomplete and poorly preserved bones of one individual lying together in matrix with the following elements represented: incomplete mandible, proximal end of right humerus, three fragments of left humerus, fragment of left ulna, distal end of right radius, proximal end of left radius overlying left carpometacarpus, LACM 126161; all from locality LACM 4547.

DISCUSSION. These specimens will be included in Warheit's study of the family Sulidae. A brief examination of the material from Upper Oso Dam reveals two humeri (LACM 120433, 120431) whose measurements exceed those of specimens of *Morus vagabundus* Wetmore, 1930, the only species of sulid that has been described from the Sharktooth Hill Bonebed. The distal breadth of the holotypic humerus of *M. vagabundus* is 18.3 mm, whereas the same measurement of LACM 120431 is 21.0 mm. The length of a referred humerus of *M. vagabundus* is 170 mm (Howard, 1966:6), and the length of LACM 120433 from Upper Oso Dam is 183 mm.

A second species of sulid from the deposits at Upper Oso Dam is indicated by specimens LACM 120428, 120432, and 120438. Although difficult to measure exactly, they suggest a smaller species. That more than one species of sulid is also represented in the Sharktooth Hill Bonebed was noted by Miller (1961:401), who reported a proximal fragment of an ulna that is larger in size than the one referred to *M. vagabundus* by Wetmore (1930). Howard (1966:7) also reported from the same bonebed two tarsometatarsi that differ from each other in qualitative characters as well as in size.

Order Anseriformes

Family Anatidae (ducks, geese, and swans)

Subfamily Anatinae (ducks)

Tribe Mergini (divers)

Mergini, genus and species undetermined

REFERRED SPECIMEN. Distal end of left femur, LACM 125994, from locality LACM 4546.

DESCRIPTION. The fibular condyle of this femur is thrust laterally, and the popliteal area is deeply depressed and angular, as is the case in diving ducks such as those of the genera *Somateria* Leach, 1819; *Mergus* Linnaeus, 1758; and *Melanitta* Boie, 1822. The fossil specimen is significantly larger than the femora of extant species of these genera, however, and the breadth of its distal end is 20.7 mm.

DISCUSSION. This femur represents a large diving anatid that was the size of a goose. In its general conformation it is suggestive of femora from the Sharktooth Hill Bonebed, which represent a large anatid species. Compared with them, however, the femur from Upper Oso Dam is more slender and the muscle scar on the internal side of the posterior face is more proximally located. Anteriorly, the intercotylar area appears to be more deeply excavated, but allowance must be made for the poor preservation of the Orange County specimen.

The femora and other bones of the anatid from the Sharktooth Hill Bonebed, which are now under study by Howard, appear to represent a new species, and probably a new genus. The single femur from Upper Oso Dam indicates the presence of a large diving anatid in the Orange County area contemporaneous with a probably congeneric, but specifically distinct bird in the Kern County area.

Order Charadriiformes

Family Alcidae (auks et al.)

Alcodes Howard, 1968

Alcodes, aff. *A. ulnulus* Howard, 1968

Figures 2I–L

REFERRED SPECIMENS. Left ulna, LACM 120434 from locality LACM 4546; left humerus, LACM 120414, from locality LACM 4545; right coracoid, LACM 121010, from locality LACM 4547.

DESCRIPTION. The holotype of *Alcodes ulnulus* Howard, 1968, is a complete left ulna (LACM 18277, Fig. 2H). The distal end of a right ulna (LACM 18279) and the proximal end of a right carpometacarpus (LACM 18278) were also referred to the same species by Howard (1968). An incomplete proximal portion of a right ulna (LACM 18280), 10 percent larger than the holotype, was tentatively referred to the species in the same publication.

The ulna (LACM 120434, Fig. 2I) from Upper Oso Dam is not as well preserved as the holotype, but resembles it by having a relatively thick shaft for its length. It is, however, slightly longer, and relatively narrower than the holotype of *A. ulnulus.* In contrast to LACM 120434 from Upper Oso Dam, the ulna of a Recent specimen of the Least Auklet, *Aethia pusilla* (UCMVZ 60629), is longer and narrower, and that of the Pliocene, flightless, auk-like swimmer, *Mancalla milleri* Howard, 1970, is shorter and broader (see Table 1). Although *Alcodes ulnulus* clearly had evolved in the direction of flightlessness, it was not as derived as any species in the genus *Mancalla* Lucas, 1901.

The humerus, LACM 120414, although incomplete (Fig. 2J), resembles the paratypic specimen (LACM 2813) of the Pliocene species, *Mancalla milleri,* in the compression of its distal end and in the height of its ectepicondylar prominence. The deltoid crest, however, is not as extensive as that of *M. milleri,* and the shaft is narrower throughout. Other distinctive characters, peculiar to the Upper Oso Dam specimen, are: proximally the pectoral attachment and external tuberosity are distinctly external to the capital shaft ridge and separated from the ridge by a depression, and the ridge is more angular; the depression below the head, internal to the capital shaft ridge extends distally to the line of the distal edge of the incomplete bicipital crest. Unfortunately, the bone is too poorly preserved to make meaningful measurements.

The coracoid from Upper Oso Dam, LACM 121010, resembles that of *M. milleri* in its straight shaft and narrow sternal facet (Figs. 2K, L). It is shorter, however, than the smallest known coracoid of *M. milleri,* from which it further differs as follows: triosseal canal angular at the anterior edge, with the tip of the furcular facet projecting farther anteriorly; anterior surface of the shaft evenly rounded throughout its length, lacking the flattening and internal projection distally that is characteristic of *M. milleri.* Its greatest length is 34.3 mm; whereas the minimum length of any specimen of *M. milleri* is 38.5 mm (Howard, 1970:8).

Table 1. Measurements of alcid ulnae (in mm).

	Alcodes ulnulus (holotype)	*Alcodes,* aff. *A. ulnulus* (LACM 120434)	*Aethia pusilla* (UCMVZ 60629)	*Mancalla milleri* (minimum)
Internal length	27.4	29.4	32.5	23.6
Breadth of shaft	2.9	2.9	1.6	3.2
Depth of shaft	4.9	3.9	2.7	5.3

DISCUSSION. These three bones are the only alcid specimens collected at Upper Oso Dam. Indeed, they are the first reported from any Middle Miocene deposit in California, including the Sharktooth Hill Bonebed. Alcids were much more abundant and diverse by Late Miocene time in southern California, however, as evidenced by the presence of at least five genera among the 27 alcid bones that have been recorded (Howard, 1968) from the lower part of the Late Miocene age Monterey Formation at a Laguna Hills site in Orange County (LACM locality 1945, the type locality of *Alcodes ulnulus*).

The genus *Alcodes* had not been previously recorded elsewhere, until the present study. When originally described, because of its apparent flightlessness, it was placed, somewhat questionably, by Howard in the subfamily Mancallinae. This subfamily had been used traditionally for flightless species in the genera *Mancalla* and *Praemancalla* Howard, 1976. Recently, his studies of the flightless alcids have led Olson (1985), however, to question the need to recognize the subfamily.

SUMMARY AND CONCLUSIONS

Fossil birds comprise part of a vertebrate assemblage discovered in marine Middle Miocene rocks at Upper Oso Dam, near Mission Viejo, Orange County, California. The fossils were collected from coarse clastic rocks that underlie shales and siltstones mapped as the Monterey Formation. The Monterey Formation has been the source of most of the previously described Late Miocene birds from localities elsewhere in Orange County. The fossil bird bones from Upper Oso Dam described in this report are from a sandstone unit that has been mapped as the Topanga Formation. Recent changes in the nomenclature of the rocks in the type area of the Topanga Formation, to the north in Los Angeles County, resulted in discontinuance of its use as a formation name. Because of this, and for other reasons, its use is probably no longer correct for rocks in Orange County, and at the present time, there is not an appropriate formational name for the source rock of these fossils.

The age of the sandstone deposit bearing these fossils at Upper Oso Dam was determined on the basis of relationships with overlying and underlying rock units, and identifications of marine and terrestrial vertebrates. The deposit is Middle Miocene in age, correlative with the Barstovian North American Land Mammal Age, and approximately correlative with the Sharktooth Hill Bonebed, which is in the upper part of the Round Mountain Silt in Kern County, California. Special attention was given, therefore, to comparisons between the avian material from these two faunal assemblages.

The poor preservation of the avian material from Upper Oso Dam has made difficult the specific assignment of the 54 avian bones represented. They are, however, identifiable as follows (numbers of individuals are given in parentheses):

Family Diomedeidae (albatrosses)
  Diomedea ?milleri Howard, 1966 (1)
Family Procellariidae (shearwaters)
  Puffinus priscus Miller, 1961 (5)
  Puffinus ?new species (1)
  Puffinus, spp. undetermined (10)
Family Sulidae (boobies and gannets)
  Sulidae, two spp. undetermined (10)
Family Anatidae (waterfowl)
  Tribe Mergini, genus and species undetermined (1)
Family Alcidae (auks et al.)
  Alcodes, aff. *A. ulnulus* Howard, 1968 (3)

The fossil bird assemblage from Upper Oso Dam is more like that from the Sharktooth Hill Bonebed than any other yet documented from the eastern North Pacific margin. However, only four of the nine avian families now represented by species in the Sharktooth Hill Local Fauna (Howard, 1984) are represented in the collection from the Upper Oso Dam site. The albatross from Upper Oso Dam is questionably assigned to *Diomedea milleri,* a species that is known only from Sharktooth Hill. A shearwater, *Puffinus priscus,* definitely occurs at both localities. Possibly one or both of the other species of *Puffinus* that have been described from Sharktooth Hill are also represented by the other material that we assign to this genus from Upper Oso Dam. The sulid bones (although not yet identified to the species level) suggest the presence of two species at the Orange County locality, as is also the case for the Sharktooth Hill Bonebed.

A single anseriform femur documents the occurrence of a large diving anatid in the deposits at Upper Oso Dam. The only previously named marine anatid from California is *Presbychen abavus* Wetmore, 1930, first described from the Sharktooth Hill Bonebed, then later found in the Late Miocene Monterey Formation in Orange County (Howard, 1968). The species from Upper Oso Dam is not *P. abavus,* but is instead probably congeneric with another, undescribed species that has been recently discovered in the Sharktooth Hill Bonebed (Howard, manuscript in preparation).

Of particular interest are the three bones from Upper Oso Dam belonging to a species of the family Alcidae. We have assigned these to the primitive flightless auk genus, *Alcodes,* and they are similar to, but not demonstrably conspecific with specimens of *A. ulnulus.* Significantly, no alcid specimens have ever been found in the Sharktooth Hill Bonebed. This contrasts with relatively abundant and diverse Late Miocene alcids, including *A. ulnulus,* in the geologically younger Monterey Formation in Laguna Hills, not far from Upper Oso Dam in Orange County.

The fossil bird assemblage from Upper Oso Dam is the oldest one yet known in Orange County. It is the southernmost documented occurrence of Middle Miocene marine birds from the Pacific border of the United States, and indeed, is the only Middle Miocene avifauna yet described from California aside from that of the Sharktooth Hill Bonebed, which is located approximately 322 km to the north.

We have noted taxonomic differences as well as similarities between the bird assemblages from these two sites. Unfortunately, poor preservation of some of the bones from Upper Oso Dam has caused us to qualify several identifications. The apparently real absence of alcids in the Sharktooth Hill Local Fauna, however, is a striking difference between that assemblage and those of Middle and Late Miocene age from Orange County. The site of deposition of the Upper Oso Dam avifauna in Orange County is on the opposite (west) side of the San Andreas Fault from the Sharktooth Hill Bonebed and, accounting for estimates of prior lateral (northward) displacement (see Hill and Dibblee, 1953; Crowell, 1975), might have originally been as much as 300 km farther south in the Middle Miocene than at the present time. This means that the two sites of deposition may have been over 600 km apart in Middle Miocene time, and this latitudinal difference must be one of the factors accounting for the faunal differences. The flightless alcids may not have had such wide distributions as the flying pelagic species. They may have been restricted to a southerly distribution, and the significant latitudinal differences between the two areas may explain why members of the group have never been found in the Kern County fossil record but are relatively common in Orange County sediments.

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